PATENT SPECIFICATION

(11) 1 528 110

1 528 110

(21) Application No. 42155/76 (22) Filed 11 Oct. 1976
(31) Convention Application No. 50/122443
(32) Filed 13 Oct. 1975 in
(33) Japan (JP)
(44) Complete Specification published 11 Oct. 1978
(51) INT CL² G03G 9/10
(52) Index at acceptance
G2C 1104 1106 1107 1108 C17Q

(54) DRY ELECTROPHOTOGRAPHIC DEVELOPERS

(71) We, FUJI XEROX CO., LTD., a Japanese Company of 3—5, Akasaka 3-chome, Minato-ku, Tokyo, Japan, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:—

The present invention is concerned with a developer for use in dry electrophotography.

The electrophotographic method generally known as xerography utilizes a light-intensive member in the form of a drum, which is prepared by vapour-depositing a photoconductive material such as amorphous selenium or a selenium-based alloy on an electrically conductive support such as copper or aluminium. The light-sensitive member is electrostatically charged and imagewise exposed to light to form an electrostatic latent image on the surface thereof, which is then developed by, for example, a cascade method, a magnetic brush method or a fur brush method to obtain a visible image using a developer containing a toner. The visible image is transferred to a suitable support by the application of an auxiliary electric charge or by corona discharge, and at the same time any untransferred toner remaining on the surface of the light-sensitive member is removed by a cleaning treatment. The light-sensitive member is repeatedly used in the manner described.

According to the cascade developing method, the developer is scooped from a reservoir by buckets provided on an endless conveyor and is dropped onto a light-sensitive member, on which an electrostatic image has been formed, thereby to develop the electrostatic image. Thereafter, the developer is removed from the light sensitive member and returned to the reservoir.

In the magnetic brush method, developers containing toner particles and magnetic carriers are attracted by a magnet in the form of a brush. The light-sensitive member on which an electrostatic image has been formed is rubbed by the brush, whereby the developers are attracted onto the electrostatic image owing to its electrostatic attracting force, thereby developing the electrostatic image.

Although the developers used in these methods are durable for many thousands of repeated uses, the carriers contained in the developers deteriorate owing to mechanical collisions between carrier particles, frictional wear and erosion of the carrier surface and toner adherence to the roughened carrier surfaces, when used for a long period of time. Such deterioration of the carrier changes the friction charging characteristics i.e. the triboelectric properties thereof, and adversely influences the quality of the copy obtained, thus making it necessary to change the carrier frequently, thereby incurring much labour and cost.

In continuously supplying conventional developers to a developer housing, the toner particles adhere to the surfaces of the carrier particles by frictional charging impact against the wall of the housing and become attached to the wall to form a film to which further toner particles become attached by frictional charging. Frictional charging between the toner particles and the toner film is not desirable for the purposes of developing a latent image. Also it is laborious to remove the toner film from the wall of the developer housing.

Moreover, conventional light-sensitive members are subject to the so-called deletion phenomenon due to external causes at the stage of charging. Deletion phenomenum refers to toner filming on the surface of the photo-sensitive materials, and the attachment of airborne impurities and contaminants to the surface. Thus, images obtained are locally blurred. When such deletion occurs, the light-sensitive member is cleaned with an organic solvent, such as isopropyl alcohol. However, it is difficult to solve the problem completely by cleaning. Consequently, it is conventional

to change the light-sensitive member at intervals, which is very expensive.

With conventional light-sensitive members, the residual developer is removed with a brush made of wool or a synthetic fiber, such as nylon or cellulose, or with a blade made of urethane rubber. However, since it is diffult to remove the developer completely from the light-sensitive member by these methods, the developer remaining on the light-sensitive member after cleaning causes the copier to make dirty copies or gives rise to the deletion phenomenon, thereby deteriorating the photo-conductivity and charging properties of the light-sensitive member. It has hitherto been necessary to grind the surface of the light-sensitive member with an abrasive solution prepared by dispersing an abrasive, such as strontium sulphate or barium sulphate, in organic solvent thereby to remove the deposited or attached developer. However, there is a fear that use of the above abrasive and organic solvent may be detrimental to the operator's health.

It is also known from British Patent Specification Nos: 1,402,009 and 1,335,732 to provide a developer which comprises toner particles, carrier particles, friction-reducing particles and abrasive particles. The diameter of the abrasive particles is approximately equal to or less than that of the toner particles. The abrasive particles are absorbed into the electrostatic image on the light sensitive member together with the toner particles and the friction-reducing particles and prevent a lubricating film of the friction reducing particles from building up on the surface of the light sensitive member.

It is also known from British Patent No. 1,343,168 to provide a toner which comprises toner particles, carrier particles and hydrophobic metal salt powder. The hydrophobic metal salt powders have a diameter which is approximately equal to that of the toner particles, and do not provide an abrasive effect.

It is an object of the present invention to obviate or mitigate the above-described difficulties and disadvantages.

According to the present invention, there is provided a dry electrophotographic developer comprising a dry electrophotographic developer comprising toner particles, carrier particles, and 2 to 10% by weight, based on the weight of toner and carrier particles of abrasive particles having a diameter of 100 to 800 μ, said abrasive particles having a toner retention capacity of one tenth or less than that of the carrier particles.

The abrasive particles incorporated into the developer of the present invention preferably have no electrophotographic developing effect. These particles do not cause substantially any charging due to friction with the toner and carrier particles. As mentioned above, the abrasive particles have a toner retention capacity of one tenth or less than that of the carrier particles which typically have the capability to retain 0.1 to 5% of the toner particles owing to charging due to friction.

Also, abrasive particles preferably have as much fluidity as the carrier particles. Because of the large size of the abrasive particles used in the developer of the present invention, an effective abrasion action is obtained which removes any toner particle film and adherent gaseous substances from the surface of the light-sensitive member by contact with the light sensitive member in the developing section. Also, the abrasive particles do not adhere to the light-sensitive member and so the abrasive particles do not affect the process after development, i.e. the transfer and cleaning stages. The abrasive particles are not consumed by repeated development. Examples of materials from which the abrasive particles can be made are silica, fused alumina, silicon carbide and boron carbide. Also, particles can be used which have raised or roughened surface portions.

When particles of one or more of the above materials are incorporated into the developer, the deletion phenomenon does not take place at all even though copying is effected as much as 5,000 to 20,000 times, whereas when 5,000 to 20,000 sheets are copied with conventional developers a significant degree of deletion occurs, particularly with selenium-arsenic light-sensitive members. Moreover, the phenomenon whereby the toner becomes attached to the inside of the machine owing to contact impulses between the carriers in the developing machine does not occur; even if this phenomenon has previously occured in large amounts, the toner is rapidly erased and removed when the abrasive particles are added, and does not built up deposits again.

As mentioned above, incorporation of these abrasive particles into the developer prevents filming on the member caused by some developer remaining even after the light-sensitive member is cleaned, i.e. the attachment of a thin film of toner particles to the surface of the photo-sensitive material or to the carriers. Therefore, the possibility of the photo-conductivity and charging properties being reduced can be eliminated without applying any abrasion, and thus it is now possible to eliminate the secondary hindrance due to the abrasive and organic solvent and the inconvenience

of reducing the life of the light-sensitive member itself.

Natural materials which can also be used to form the abrasive particles include powders of corundum, emery, garnet, tripoli, diatomaceous earth, spinel, lime and flint shot; synthetic materials which can also be used include powders of alumina, iron oxide, chromium oxide, cerium oxide and calcined dolomite.

In developers for electrophotography, the carrier and toner particles become attracted to one other owing to frictional charging, thereby producing a developing effect. When abrasive particles are incorporated into the developer, however, the above effect is completely eliminated. Also, where some friction charging has occurred, the contrast with the background increases markedly when such particles are used in the developer as compared with the case where the carriers have deteriorated, whereby good images can once more be obtained.

For this reason, the friction charging characteristics of the particles incorporated into the developer are preferably low, so that the materials carry substantially no toner particles on their surfaces during development.

Examples in which developer according to the present invention are utilized will now be described.

Example 1

With a selenium alloy light-sensitive member (arsenic 35% by weight) and a developer containing toner particles and carrier particles and also silicon sand (Ottowa Sand) of 500 to 590 μ diameter in an amount of 2.5% by weight based on the weight of the toner particles and carrier particles, a 20,000 sheet continuous copying operation was conducted, and then the charging properties of the carrier, the contamination of the inside of the developing machine, the surface potential of the light-sensitive member, and the deletion of the light-sensitive member were examined.

Charging Properties of the Carrier

Comparison Developer	11.0 μc/g
This Invention	13.5 μc/g

Contamination of the Inside of the Developing Machine

Comparison Developer	Solid Attachment
This Invention	No Attachment

Surface Potential of the Light-sensitive Member (obtained by measuring the charged potential when a D.C. corona discharge was carried out after copying 20,000 sheets)

Comparison Developer	700 V
This Invention	790 V

During this continuous copying, no deletion phenomenon of the light-sensitive member occurred, and the surface of the light-sensitive member remained clean.

Example 2

With a developer containing toner and carrier particles to which Ottowa Sand with raised portions of 500 to 800 μ diameter (rougher than the sand in Example 1) was added in an amount of 5.0% by weight based on the weight of the toner and carrier particles, and a light-sensitive member on which deletion had occurred, a 3,000 sheet continuous copying operation was conducted. At the end of the copying the deletion areas on the light sensitive member had been erased and the light-sensitive member has recovered or been restored to the extent that sharp copies could be obtained. The initial surface potential at the areas where deletion had occurred was 200 V, and when the test was finished such areas had potentials of 750 V.

Example 3

A developer containing toner and carrier particles to which Sakrundum # 54 (a mixture of fused alumina and Al_2O_3 produced by Nippon Carlit Co., Ltd.) particles of 297 to 420 μ diameter was added in an amount of 3.0% by weight based on the weight of the toner and carrier particles was tested in the same manner as in Example 1, and results similar to those of Example 1 were obtained. In respect of the amount of toner attached to the surface of the carriers, good results were obtained.

The amount of charging between the Sakrundum #54 and the toner was –0.56 μc/g.

Example 4

With a developer containing toner and carrier particles to which Morundum #46 (Al_2O_3 particles produced by Showa Denko K.K.) having a diameter of 420 to 500 μ was added in an amount of 7.0% by weight based on the weight of the toner and carrier particles, and a light sensitive member on which toner-filming had occurred and with which no sharp copies could be obtained, a 3,000 sheet continuous copying operation was conducted. The last copies at the end of the run had good image sharpness and high picture density or contrast.

The surface potential of the light-sensitive member increased by 80 V after

the 3,000 sheet continuous copying operation had been conducted.

WHAT WE CLAIM IS:—

1. A dry electrophotographic developer comprising toner particles, carrier particles and 2 to 10%, based on the weight of the toner and carrier particles of abrasive particles having a diameter of 100 to 800 μ, said abrasive particles having a toner retention capacity of one tenth or less than that of the carrier particles.

2. A developer as claimed in Claim 1, wherein said abrasive particles have the same degree of fluidity as the carrier particles and exhibit no electrophotographic developing effect.

3. A developer as claimed in Claim 2, wherein said particles are made of one or more of the following materials: silica, fused alumina, silicon carbide, boron carbide, corundum, emery, garnet, tripoli, diatomaceous earth, spinel, lime, flint short, iron oxide, chromium oxide, cerium oxide and calcined dolomite.

4. A dry electrophotographic developer as claimed in Claim 1, substantially as hereinbefore described.

MARKS & CLERK,
Alpha Tower,
ATV Centre,
Birmingham B1 1TT.
Agents for the Applicants.

Printed for Her Majesty's Stationery Office, by the Courier Press, Leamington Spa, 1978
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.